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Mapping closed and open innovation practices: a comparison across nine countries based on micro-level innovation survey data

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Mapping closed and open innovation practices: a comparison across nine countries based on micro-level survey data*

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Abstract

This paper sets about identifying different and complex innovation practices across nine countries by exploring data from firm level innovation surveys conducted in nine countries: Austria, Brazil, Canada, Denmark, France, New Zealand, Norway, South Korea and the United Kingdom. Our results suggest that innovating firms in these countries adopt one or more of the following innovation modes: (i) 'new-to-market innovating', (ii) 'marketing based imitating', (iii) 'process modernising', (iv) 'wider innovating'. The extent to which IPRs, external technology, design or marketing activities play a role in these innovation practices varies across countries. For example, in Austria, Denmark and New Zealand diffused technology (externally acquired R&D) is used together with own technology in bringing about novel products, suggesting a more open innovation pattern. In contrast, among firms in France, New Zealand and the UK we identify a greater reliance on IPRs (e.g. patents, copyrights and design registrations) while at the same time omitting externally acquired technologies. The latter may be interpreted as leaning towards a closed approach to innovation among a group of firms.

JEL classification: O12; O57; O32

1. Introduction

There is considerable evidence that innovation plays an important role in shaping the growth and competitiveness of firms, industries and nations. Innovation is linked to increased welfare, the creation of new types of jobs and the destruction of old ones. At the firm level, innovation is a source of performance and competitiveness. Reflecting further on the outcomes of innovation, accumulated analytical results suggest that a combination of technological and non-technological innovation activities is especially pertinent to performance and firms that engage in both product and process type innovations and, at the same time, introduce organisational changes outperform firms that concentrate on one or the other activity (Geroski, Machin and van Reenen, 1993). While a range of activities, e.g. the introduction of a new product, a new marketing concept, are acknowledge to be important, less attention has been placed on deriving complex measures of innovation practices which reflect on the kind of activities which are done simultaneously by firms to form a mode of innovation.

Moreover, different innovation practices are likely to be changing over time and across locations. For example, it is argued that we are in the midst of a paradigm shift in innovation practices, moving from closed innovation practices which were favoured more strongly in the past, towards new forms of open innovation practices (Chesbrough, 2003). Closed innovation practices, mean that a company does not rely on outside sources to bring about innovation, and are linked to the importance of in-house R&D facilities, skills of the workforce, and the protection of innovation effort through IPRs. Open innovation practices on the other hand suggest sourcing ideas to innovate from outside the firm, the joint exploration and generation of innovations, and, in relation to IPRs, a more strategic use. For example, patent pools and the licensing in or licensing out of patents may be used to manage and profit from access by others to internally generated technology, and, in turn, to use technology generated by others (Andersen and Konzelmann, 2008; Blind, Edler, Frietsch, Schmoch, 2006).

There is substantial empirical evidence suggesting that firms increasingly rely on internal and external sources (e.g., Cassmain and Veuglers, 2005) or joint generation of innovations through cooperation (e.g. Freeman, 1991, Haagedorn, 2002, 2003 and Mowery, 1999). Networks and feedback loops between and within firms are also emphasised by systemic approaches to innovation (Freeman, 1987, Lundvall, 1992, Nelsen, 1992).

Innovation practices, whether leaning towards an open or closed model of innovation, are also likely to differ across locations. Differences in socio-economic environments and the characteristics of national innovation systems influence innovation practices adopted by firms in specific locations. The strengths of the R&D system, system of governance, strengths of IPR system and educational system, are all likely to affect the type of innovation modes adopted across local firms, and their propensity to source knowledge for innovation inside or outside the firm.

The aim of this paper is to identify different and complex innovation practices across nine countries by exploring data from firm level innovation surveys conducted in the following nine countries: Austria, Brazil, Canada, Denmark, France, New Zealand, Norway, South Korea and the United Kingdom. In doing so, it captures the extent to which firms' innovation practices in different countries lean towards more open or closed innovation practices. This paper is part of a wider study measuring non-technological innovation practices, conducted under the auspices of the Organization of Economic Cooperation and Development during 2007, with the UK team as co-ordinator.

While much of the empirical innovation literature is concerned with the determinants and effects of innovation (or a combination of them) across various levels of analysis (including firms, industries/technologies and nations), using individual variables to represent inputs and outputs. The key contribution of this paper lies with (i) measures of innovation practices at the firm level, and with (ii) patterns of innovation at the country level, i.e. the relevance of different national systems of innovation in shaping the innovation practices of firms in a specific country. In order to identify complex modes of innovation practices, the paper adopts an explorative approach to research. Factor analysis techniques are used to derive summary variables that represent 'modes of innovation'.

Analysis and modelling of the economics of innovation has traditionally concentrated on the definition and role of technological changes, usually measured by R&D or patents (Archibugi and Pianta, 1996; Smith, 2005). But the importance of other dimensions of innovation, such as managerial or organisational change, investment in design or in skills, and the management of the innovation process itself, are increasingly acknowledged as equally important. This is reflected in the new *Oslo Manual*. While the latter does not distinguish between technological and non-technological innovations, it recognizes the importance of organisational and

marketing changes next to innovations in products and processes. However, in light of the number and scale of innovation survey data sets across countries, limiting methodologies to the use of organisational and marketing innovations on the one hand and product and process innovation on the other hand, seems an oversimplification and the large volumes of data now available enables us to explore a much richer set of possibilities and groups of activities.

The paper is a highly relevant contribution because it addresses aspects of innovation that have had less attention in the analytical literature so far, than have purely technological dimensions based on R&D and patent analyses. To-date this study is perhaps the most internationally comprehensive, by identifying innovation practices across a mixed set of OECD countries; comprehensive in terms of the number of countries involved in the project, the number of variables feeding into the analysis and the number of data observations used in each country. The study includes a diverse range of economies: countries in North and South America, Asia, and a group of small and large European economies.

The paper is structured as follows: Section 2 introduces the theoretical context of the study. Section 3 explains the data and methodologies and Section 4 discusses country specific results, while Section 5 summarises and concludes.

2. Theoretical context

This section provides a discussion on the development of indicators of innovation activities over time, and, thus, provides the rationale for the importance of working towards a better understanding of complex innovation practices adopted by firms.

Traditionally, empirical and theoretical works on the determinants and effects of innovation were confined to technological activities (e.g. Cohen, 1995, Smith 2005). This depended from the large proportion of innovations in high technology manufacturing sectors based on new technology, including activities carried out in R&D departments (e.g. Fagerberg, 2005). Literatures on innovation have focused on two Schumpeterian definitions of innovations; the introduction of a new product and the introduction of a new production process (Schumpeter, 1934). A similar approach to capturing innovation was suggested in the 2nd revision of the Oslo Manual with an emphasis on technological components:

> *A technological product innovation is the implementation / commercialisation of a product with improved performance characteristics such as to deliver objectively new or improved services to the consumer. A technological process innovation is the implementation / adoption of new or significantly improved production or delivery methods. (OECD, 1996: 8)*

With the introduction of the 3rd revision of the Oslo Manual in 2005, the above definition – now referred to as narrow definition of innovation – has been extended to encompass organisational and marketing changes, and to include non-technological characteristics of product and process innovations.

> *An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. (OECD, 2005: 46)*

The need to cover properly innovation in the provision of services, which now dominate OECD economies, has also been a major force behind these changes in concept. In tandem with, if not somewhat ahead of, the shift in emphasis in the Oslo Manuals, have been changes in the Community Innovation Survey (CIS) questionnaires and in the similar innovation surveys in other countries. In CIS2 the definition of technological product and process innovations as recorded in the 2nd revision of the Oslo Manual was adopted; since CIS3 the word 'technological' has been dropped from the various questionnaire items measuring product and process innovation.

The recent changes in data collection methods recommendations and questionnaire items are mirrored in increased theoretical and empirical works considering broader measures and/or modes of innovation. For example, a number of recent papers focus on the determinants and effects of marketing and organisational types of innovations (e.g., Acha and Salter, 2004) and innovation in services (e.g., Diellal and Gallouji, 2001, Tether and Miles, 2001).

In conjunction with such research, a loose distinction is made between technological types of innovations and non-technological types of innovation. By and large, product and process innovations in manufacturing firms are considered technological, whereas organisational types of innovations, marketing innovations and/or innovations in services are considered as non-technology based (e.g., Battisti

and Stoneman, 2007). Moreover, such activities tend to be treated distinct from one another.

However, product and process type of innovations are likely to have non-technological components, and organisational and marketing innovation are often helped by technological knowledge. Confining non-technological innovation to organisational and marketing innovation may be, in practice, a convenient simplification given the variations in coverage and variables collected in innovation surveys across countries; however, it is likely to give an inaccurate or at best incomplete picture of the extent of complementarity between these dimensions of innovation inputs and outputs.

A number of studies have aimed at identifying different modes of innovation practices. In particular, Hollenstein (2002) examines different modes of innovation in the service sector based on the Swiss Innovation Survey. In his paper, Hollenstein uses factor and cluster analyses to group firms into five categories which include specific ratings of firms in terms of their technological vs. non-technological activities. He finds that firms which engage in all activities are more likely to engage in cooperation and have a higher innovation output. Jensen, Johnson, Lorenz and Lundvall (2007) cluster firms into different modes of knowledge. These are "Science, Technology and Innovation" mode and "Doing, Using and Interacting" using the 2001 Danish DISKO Survey. They, too, find evidence that firms which engage in a combination of knowledge generation and acquisition outperform in terms of product innovation output. In a similar vein see Howells and Tether (2007) using Innobarometer data.

Battisti and Stoneman (2007) use the UK CIS4 to identify different modes of innovation activities. They, too, use both factor and cluster techniques to explore the data. The two modes of innovation they identify are: "wide innovative activities", including marketing, organisational, management and strategic innovations; and "traditional activities", including product, process and technological innovations. They link these modes to firm performance and find that "wide innovative activities" and "traditional activities" are complements rather than substitutes and enterprises engaging in both exhibit higher levels of performances.

Although the above studies use a distinction between technological and non-technological activities, there remains considerable overlap between the modes or classification of activities identified. This paper uses similar methods to Hollenstein

(2002), Jensen *et. al* (2007), Battisti and Stoneman (2007) and Peeters, Swinnen and Tiri (2004) for the purpose of exploring overlap or mixed modes of innovation practices across nine countries.

We do not *a priori* expect to find entirely common patterns across countries; instead we expect that differences as well as communalities in country results will further our knowledge as to how respective innovation systems function, their similarities and how they differ. On the one hand, innovation practices are likely to depend on differences in national and regional innovation systems and country specific socio-economic environments. On the other hand growing international dependency among economies and in particular the activities of transnational corporations, and their role in the generation and diffusion of innovations across national borders, may tend to increased convergence in innovation practices. The findings in this paper shed further light on the extent to which differences across nations or regions matter. The next section introduces the datasets, variables and methodology, followed by a discussion of the results and conclusion.

3. Data and methodology

This section discusses data and methodology. The datasets used in the analyses are based on those items in the fourth (harmonized) CIS questionnaire on which information is collected across all (or most) countries included in this study. Thus, we chose to work with a smaller set of variables than would be possible in individual countries. This choice, with the aim to achieve the highest level of comparability across countries, will tend to limit the ability of the models reported here to "fit" the salient characteristics of the individual countries. We centrally wrote the STATA routine which was then simultaneously run by the participating countries on their respective micro dataset. The next section gives an overview of the variables included in the study which is followed by a discussion of the statistical techniques.

Data

Initially, variables feeding into this study were selected from the questionnaire items included in the harmonized survey questionnaire of the Fourth CIS. Here, we introduce those variables, including their definitions, and make some reference about whether or not an activity is likely to lean towards non-technological engagements. Our analysis of modes of innovation practices incorporate measures of innovation

outputs, e.g. a new product, together with innovation inputs, e.g. R&D activities or patent application. These measures are summarised to represent modes of innovation practice. To illustrate, a possible mode of innovation would be new-to-market product innovations together with in-house R&D and the use of intellectual property rights, classed as an innovation practice with a high technological component. Alternatively, practices may centre around design and new marketing strategies and lean towards non-technological engagements. We thus depart from a simple inputs-outputs way of framing the innovation process towards a more systems based approach.

Broad headings under which we introduce the selected questionnaire items feeding into the factor analyses are: product innovation, process innovation, marketing and organisational innovation, own technology, diffused and embedded technology, design and other inputs. Table 3.1 summarises the set of variable on the basis of which modes of innovation practices are identified.

Table 3.1 here

The left column of Table 3.1 gives a description of the questionnaire items and the right column the names used to identify the respective variable in this study. With respect to *innovation outputs*, the innovation surveys include information on innovations in products and processes. These may be based on both technological and non-technological activities. Under the title 'organisational and marketing innovation' the surveys include changes to management techniques and organisational structures, marketing strategies and the appearance of products. The latter activities are likely to incorporate a high share of non-technological related activities.

On the side of *innovation inputs*, we consider in-house R&D as the traditional form of own generation of technology. We also consider inputs of bought in and diffused technology such as extra-mural R&D, the acquisition of machinery, equipment and software, and of other external knowledge. Moreover, innovation inputs captured in the surveys may include design functions and marketing activities. Whether or not a firm registered a design or used copyrights is used in this study as a proxy for design related activities, which are partly non-technological, but also an important component of developing and applying technologies. With respect to

marketing activities, a survey question covers expenditure on marketing preparation for innovations. This is considered largely a non-technological input. Finally, we include training of employees in relation to innovations in the set of variables as one indicator of investment in human capital

The following restriction with respect to *sample selection* was made. Observations feeding into the analysis are those from innovation active enterprises – using a Eurostat definition. This is done for two reasons. First, because we are interested in exploring the range of practices among innovative firms, and second, because not all information included in Table 3.1 is available for non-innovation active enterprises. An enterprise is considered to be innovation active if it had a product innovation or a process innovation or any innovation activities to develop product or processes that were abandoned or still ongoing during the reference period of the surveys. In terms of the industry sectors included, observations cover all manufacturing and most private services, with the exception of the Brazilian and Canadian dataset where the analysis is based on manufacturing firms only. The reference period for the innovation surveys is 2002 to 2004 with the exception of Austria where results were computed using an earlier version of the innovation survey referring to activities during the three year period 1998 to 2000. The next section describes the statistical tools selected to examine the variables and observations discussed here.

Methodology

As discussed in Sections 1 and 2, the aim of this study is to identify mixed modes of innovation and to compare these across different national systems of innovation. Therefore, our point of departure – rather than operationalising and testing conceptual hypotheses – is to use observable patterns in the innovation surveys to arrive at a new conceptual understanding of modes of innovation practices. To address the above aim we use factor analyses to derive latent modes or practices of innovation.

We use explorative (as opposed to confirmatory) factor analyses. The technique is used to reduce a set of variables to underlying concepts (factors) which summarise combinations of innovation inputs and outputs. In other words, we would like to discover which variables (listed in Table 3.1) form coherent subsets. The variables of a subset are correlated with one another and the strength of their correlation is summarised in factor loadings. Variables which score high in one factor

are largely independent from other factors, but with some exceptions, where loadings on a variable are similar across more than one factor.

All variables feeding into the factor analyses and included in Table 3.1 are measured on a binary scale. If an enterprise engaged in a specific innovation related activity, for example reporting a new-to-market product during the reference period of the survey, then the variable new-to-market product innovation is coded one, otherwise zero. Although, the innovation surveys contain continuous data for some of the variables included in Table 3.1, such as the amount spent on R&D, we do not use this information for technical reasons. Since all participating countries applied a centrally written STATA do file to simultaneously run the same estimations on their respective datasets, the analysis is restricted to using the normal STATA commands available for factor analyses. Analysing a mixture of binary and continuous data requires factor analysing a polychoric correlation matrix. Such a command is available for STATA, but has been written by a user and needs to be imported into STATA . This was not possible for most countries where data was analysed in statistical offices.[1]

The binary data factor analysis involves the computation of a tetrachoric correlation matrix, and factor analysing this matrix, under the assumption that the observed binary variables correspond to latent continuous variables.[2] A similar approach is used in Battisti and Stoneman (2007) in an analysis of the UK CIS. We compute four factor solutions for all countries, in order to maximise comparability of results. In most cases this corresponds with the number of factors which have eigenvalues greater than one; any deviation from this rule, i.e. the inclusion of factors with eigenvalues smaller than one or exclusion of factors with eigenvalues greater than one, is discussed in the relevant results section. We present results based on unweighted data, principal component analysis and varimax rotation method, unless specified otherwise. In the case of Austria, Brazil, and the UK we also computed results based on (i) weighted data and (ii) oblique rotations and found the results to be very similar to the structure presented here.[3] Finally, an advantage of factor analysis is that it provides indicators in the form of factor scores, regression methods were used

[1] In the case of the UK we computed results based on polychoric correlations and found similar patterns compared to the analyses presented here.
[2] Results derived through principal component analysis based on Pearson correlation coefficients should lead to similar results.
[3] Results can be made available on request.

to compute the factor scores, which have a low degree of correlation (Fidell and Tabachnick, 2006). The factor scores can themselves be used as variables in models to estimate the relationship between modes of innovation and economic performance.[4]

We identify factors taken to represent different modes of innovation which are interpreted by inductive reasoning, i.e. moving from the specific observation to the general concept. This interpretation of underlying modes of innovation activity increases our understanding of what innovation strategies are prevalent in the countries involved.

4. Results

In this section we present results of the factor analysis and their interpretation as modes of innovation, on a country-by-country basis. Because of the explorative nature of this study, and the separate discussion of the findings for each country, this section is in parts descriptive in nature. Section 5 discusses important communalities and differences across the nine countries.

Austria

Austria is a medium sized social market economy. The economy is characterised by high income levels and high standard of living. The bulk of GDP derives from services, specifically consultancy and finance firms as well as tourism. Firms in Austria tend to be less internationalised compared, for example, with firms in the UK and the Nordic countries, with the exception of the steel sector, and chemicals and oil companies, more dominated by multinationals. Over the last 10 years, considerable emphasis has been placed on innovation policies aimed at raising the level of business R&D (OECD, 2007). The Austrian dataset used differs from other datasets in that:

Austrian data refers to the third wave of the Community Innovation Surveys with the reference period 1998 to 2000. Similar to the UK, the dataset contains items on organisational and marketing innovations which differ slightly from the harmonized questionnaire. This is reflected in the variable names included in Table 4.1 below which gives the factor loadings forming four distinct modes of innovation.

[4] Such models have been estimated successfully as part of the OECD project, but are not included in this paper.

Table 4.1 here

Because the Austrian results are the first set of results we introduce, the discussion of Table 4.1 is more elaborate compared to subsequent country results. The first column shows the factor loadings[5] for Factor 1, interpreted as *new-to-market innovating* based on own and diffused technology with design. This mode/practice shows a high loading on new-to-market product innovations (r=0.76), together with technological activities (in-house R&D: r=0.89, patent: r=0.88 and external R&D: r=0.72) and design related activities (design registration: r=0.79 and copyright: r=0.52).

Factor 2 attaches high values to organisational/marketing innovations, and we call this factor *wider innovating*. Variables with high loadings are the use of advanced management techniques (r=0.70), improved organisational structures (r=0.69), and improved appearance or design of products (r=0.71) and new marketing strategies (r=0.81). Thus, wider innovating leans towards non-technological activities. Factor 3 is interpreted as *process modernising* due to high loadings on process innovations (r=0.56), the acquisition of machinery and equipment (r=0.67) and of other external knowledge (r=0.68) and training (r=0.74) – a combination of (embedded) technological with non-technological components.

Finally, Factor 4 is summarised under the heading *marketing based imitating*. This practice is largely based on the introduction of new-to-firm (only) innovations (r=0.78) associated with marketing related expenditures (r=0.59). Own and diffused technologies load up negatively on this factor. This mode of innovation appears to emphasise non traditional activities; in particular marketing concepts and excludes technology based activities.

Brazil

Measured by geographical region and population size, Brazil is the fifth largest economy in the world. Brazil has a diverse range industry including automotive, steel, chemicals, computers and aircrafts. Over recent years the service sector has been

[5] Factor loadings are the correlation between each variable feeding into the analysis and the factor computed by the analysis. For example, the variable 'new-to-market product innovation' has a correlation of r=0.76 with Factor 1. Within a factor, high values indicate that the respective variables 'load up' jointly and together represent one underlying concept, one mode of innovation. These underlying concepts are interpreted and discussed here, based on the judgements of the authors.

increasing and banking accounts for approximately 15 percent of today's GDP. Almost three quarters of R&D is publicly funded and much research is carried out within universities and research institutes as opposed to the business sector. Overall R&D spending is comparatively low at one percent of GDP (OECD, 2006a).

The data analysed is from the Technological Innovation Survey 2003 (PINTEC2003), which covers the mining and quarrying and manufacturing sector and the latter has been covered in this project. The reference period of the survey is 2001 to 2003. In the case of Brazil the sampling frame is divided into three strata associated with the different (high, medium, low) probabilities of being innovative. Therefore, to account for this difference in sampling techniques compared with other surveys, which are based on stratification around enterprise size, sector and region, weighted and unweighted results were compared. We found that both factor analyses gave highly similar results. Here, we present the factor analysis based on unweighted data. A variable on new relations with other organisations, under organisational innovations, is not included in PINTEC 2003. Table 4.2 gives the results of the factor loadings.

Table 4.2 here

The first factor is titled *new-to-market innovating* and links own technology (in-house R&D and patents) and design activities. This factor is similar to the Austrian innovation practice 'new-to-market innovating'; however, the design element in this innovation mode is so far unique to Brazil. The second factor is interpreted as *marketing based imitating*. This factor exhibits a high loading on new-to-firm product innovation combined with marketing expenditures; with some relevance of R&D. The third factor is summarised as *process modernising*, a mode is based on technology embedded in machinery, equipment and software and connected with training of staff to encourage innovation and a high propensity to new-to-firm product innovation. Finally, the fourth factor, entitled *wider innovating***,** links changes in the organisational structure, new design and packaging and improved distribution methods. Thus, this factor groups non non-technological activities.

Canada

Canada's innovation system is highly advanced. The industrial environment is influenced, among other things, by a large service sector – three quarters of the population are employed in services generating two thirds of GDP. Canada is relatively abundant in natural resources with strong forestry and oil sectors. According to the OECD's Economic Survey (2006), Canada exhibits comparatively high levels of product innovation vis-à-vis other innovation outputs.

As is the case for the Fourth CIS conducted in Europe, the reference period of the Canadian innovation survey is the three year period 2002-2004. However, the Canadian data is based on manufacturing enterprises only, i.e. services are not included. This may be more problematic than in the case of Brazil, since it omits a larger part of the economy. The Canadian survey does not include information on organisational or marketing innovations, but includes data on marketing expenditures and registration of design. Because no variables in relation to organisational and managerial innovations are available, a three factor solution was produced to increase the comparability of results across countries.

Table 4.3 here

The Canadian three factor solution results are interpreted as follows. Factor 1 is a factor combining *in-house and market driven innovating*. Such activities are based on own technology and marketing activities, with some relevance of design functions. Process innovating has a negative loading on this factor, suggesting a strong demarcation between innovating in products on the one hand and in processes on the other hand. The second factor relates to *process modernising*, based on embedded technology and training. Factor 3, summarises a mode concerned with means of protecting innovations and inventions from imitations, specifically copyrights and patents, and to a lesser degree design registrations. The latter is the only IPR related variable that also loads highly in Factor 1, in-house / market driven innovating. Additionally, to IPR related variables, Factor 3 has comparatively high loadings for external R&D and external knowledge. We call Factor 3 *IPR and external innovating*. The association between bought-in R&D and other knowledge and strategies of appropriation suggests that, in the case of Canadian firms, external search may be

more likely to take place when IPRs protect innovation efforts. A similar observation was made Laursen and Salter (2005) based on UK study and the related phenomenon of the "open innovation paradox". Acha (2007) found that design registration and complexity is positively associated with open innovation.

Denmark

Denmark is a small, advanced and comparatively open economy. Service sector, high-tech manufacturing and agriculture form important segments of the economy. The data analysed is CIS4. All sectors and variables introduced in Section 3 are available. Table 4.4 shows the loadings for the four factor solution.

Table 4.4 here

Factor 1 summarises a mode of innovation associated with own and diffused technologies. The factor is interpreted as *technology producing and using*. High loadings are given to in-house R&D, bought-in R&D and patenting. Other variables to do with IPRs, copyrights and design registration do not show a specifically high loading. Factor 1 exhibits a positive loading for product innovation outputs. Furthermore, marketing expenditures also appear to play an important role indicating that technological efforts are likely to be complemented with research into new markets. The second factor summarises a mode of innovation that links new-to-market innovations with design activities, including the development of new designs and packaging, design registration, copyrights, marketing expenditures as well as new sales methods. We refer to Factor 2 as *new-to-market/design innovating*. Both Factors 1 and 2 are related to new-to-market innovations which involve on the one side design and on the other side technology.

Factor 3 exhibits high loadings for organisational changes, marketing innovations, and training and, similar to previous discussions, is termed *wider innovating*. Factor 4 called *process modernising* based on high loadings of process innovation, acquisition of new machinery, equipment or software, external knowledge and training. Factors 3 and 4 represent modes of innovation practices which are found in similar ways across the four countries discussed so far, whereas the key differences reported here are to do with the factors linked to product innovation.

France

Next to the UK, France is the largest European economy included in this report. This section summarises the findings of the factor analysis based on the Fourth CIS for France. The analysis is based on pearson correlations, rather than tetrachoric correlations. Table 4.5 gives the factor loadings for the four factor solution.

Table 4.5 here

The results of the French data produce one factor which combines previously found concepts of new-to-market innovating, technology generating and adopting, and process modernising. This appears to be a single mode of innovating which may be interpreted as "doing-it-all" or *technology innovating and process modernising*. Factor 2 has high loadings for organisational and management changes and Factor 4 groups new design, packaging and sales methods. Previous country results linked these two factors into a single factor which we called wider innovating. We interpret Factor 2 as *organisational innovating* and Factor 4 as *marketing based innovating*. Factor 3, relates to *IPR innovating*, i.e. emphasises formal and informal techniques of protecting inventions and innovations from imitation through activities which lean more towards technological activities – patents – as well as activities which are perhaps more likely to be based on non-technological activities – design and copyrights.

New Zealand

The analysis for New Zealand is based on the Business Operations Survey 2005 (BOS2005). The relevant questions cover a two year period as opposed to the three year reference period used in most other innovation surveys. The second reference year is the latest financial years for which information is available: either 2004 or 2005. The following variables differ from most other definitions: (i) new-to-firm product innovation also relate to innovations obtained from others with no significant improvements by the business itself; (ii) new management techniques is measured is a change to organisational and managerial processes with the implementation of new business strategies or management techniques; (iii) changes in organisational structure means a change to organisational or managerial processes and organisational

restructuring; (iv) new design suggests that a firm engages in marketing changes and design activities; (v) in relation to IPRs the variables captures if an enterprise held a patent, copyright or design registration (as opposed to applying for or claiming an IPR as is the case in CIS).

The factor analysis is based on innovation active firms. The definition of innovation active differs from other counties and includes firms which engage in any of the following: product innovation, process innovation, organisational innovation or marketing innovation (studies based on CIS additionally consider enterprises with ongoing or abandoned innovation projects as innovation active).

Table 4.6 here

The first factor identified in the New Zealand dataset has high correlations with process innovation, management and organisational innovations, and machinery and training. It comprises elements of process modernising and wider innovating. We call this factor *business process modernising.* Businesses scoring high in relation to this factor tend to innovate in processes, introduce new management techniques and make changes to their organisational structure.

The second factor is interpreted as *technology producing and using*. Firms engage in internal R&D, external R&D and the acquisition of external knowledge together with design. There is a positive association with new-to-market innovations. This mode of innovation relates strongly to technology (diffused and generated), design activities and novel products. Factor 3 takes high loadings on IPRs. This factor, too, is linked to new-to-market innovations. Similarly to Denmark and France, we call this factor as *IPR innovating.* The fourth factor is titled *marketing based imitating*. A similar factor emerged from the Austrian and Brazilian datasets. This factor takes high loadings for new-to-firm innovations with engagement in marketing activities.

Norway

In this section the Norway specific results are discussed, starting with the factor analysis summarised in Table 4.7. In the case of Norway, the data suggested a six rather than four factor solution, with six factors generating eigenvalues greater than

one. As a result, the four factor solution presented here leaves a high uniqueness to the variable new-to-firm product innovation, i.e. this variable appears to be a rather distinct concept compared to the remaining variables.

Table 4.7 here

Factor 1 is interpreted as *technology adopting* with high loadings on diffused technology embedded in machinery and external knowledge. This is linked to training and marketing activities. This factor also has a positive loading on new-to-market innovations. Factor 2 is interpreted as *business process modernising,* rather similar to one of the New Zealand factors which loads both process modernising with wider innovating. Contrary to the results in New Zealand, embedded technology (machinery) and training do not load up with the factor business process modernising in Norway. Factor 3 exhibits high loadings on *IPR/design innovating*. Interestingly, new design and packaging features in factor 3, a somewhat different pattern to other countries. Factor 4 is associated with *technology producing and using***,** with gives high loadings of internal and external R&D as well as patenting.

South Korea

This section explores the results for South Korea. In the Korean innovation survey 2005/6, no information regarding copyrights is collected. Information on all other indicators is available. Table 4.8 presents the results.

Table 4.8 here

Factor 1 is interpreted as *IPR/in-house innovating* based on high loadings of own R&D together with patent and design registration. Innovation in products, both new-to-firm and new-to-market is also highly correlated with Factor 1. Factor 2 exhibits high loadings in the case of *organisational innovating*, and Factor 3 shows high loadings in the case of *marketing innovating*. Like the results for France, and contrary to the findings in the remaining economies, innovation practices to do with organisational and managerial changes do not necessarily go hand-in-hand with

marketing innovations in the case of South Korean firms. Factor 4 summarises activities associated with internal and external R&D and external knowledge, also including technology embedded in machinery and training. We call this factor *technology producing and using*, similar to factors found in the case of Denmark, New Zealand and Norway.

The United Kingdom

The UK is the second largest economy covered in this study. Despite relatively low international rankings on traditional, technology oriented indicators of innovation such as patenting and R&D, recent economic trends have seen relatively high productivity growth which supports the need for broader measures to identify the innovation practices which lead to improved performance. While the UK survey does not collect information on new or significantly changed relations with other firms or public institutions as suggested by the harmonized CIS questionnaire, the UK innovation surveys collect information on: (i) implementation of advanced management techniques, (ii) changes in the organisational structure, and (iii) changes in marketing concepts or strategies, which are used as equivalents to the harmonized questionnaire variables in this section. Table 4.9 gives the results of the factor analysis.

Table 4.9 here

The first factor is interpreted as a mode of innovation practice which we call *IPR/in-house innovating*. This factor is based on high loadings of protection of inventions and innovations from imitation, including patents, design registration and copyrights. The in-house component is also linked to a relatively high loading of own technology. IPR/in-house innovating loads up with new-to-market product innovations. Innovation practices based on strong IPRs are not unique to UK firms, but emerge in countries with advanced innovation systems, such as France, Canada and New Zealand. Strategies of appropriation appear less relevant in smaller, perhaps more open, economies, such as Austria and Denmark; or more emergent economies, such as Brazil and South Korea.

We call Factor 2 *process modernising* based on process innovation, in-house R&D, external R&D and knowledge and other inputs including training and marketing expenditures. In other words, this factor summarises own generation of technology, diffused technology with other activities (training and marketing). Factor 3 is referred to as *wider innovating* and links managerial, organisational and marketing changes. Enterprises which innovate through improved managerial techniques tend to advance the structure of their organisations and marketing strategies at the same time. Wider innovation practices are relevant in most countries.

Factor 4 combines innovation outputs in products, both new-to-market and new-to-firm, with marketing expenditures, and notably excludes innovations in processes. We call this factor *market driven innovating*. Enterprises that engage in this mode of innovation recognise the need to take a specific approach to their market place to effectively bring about their innovations. Market intelligence and marketing spending also load up with own and diffused technology. The negative loading of process innovation may be explained by the product life cycle an innovation passes through.[6] For example, at the start of the product cycle firms are likely to be concerned with and compete via the introduction of new and improved products, whereas in the later stages of a product cycle the emphasis shifts towards process innovation and, then, competition is based on improved efficiencies in the production of existing products. In the case of services some evidence points to the reverse situation where process innovation in the initial stages are replaced by increased innovations in goods at the end of the cycle.

Across factors an interesting finding is that in-house R&D loads up positively, on three modes of innovation practices: IPR/in-house innovating, process modernising and market driven innovating. Marketing expenditures are relevant across two factors: process modernising and market driven innovating.

5. Conclusion and discussion

This section brings together the country results with the aim of identifying common modes of innovation practices across the nine countries. Table 5.1 summarises the modes of innovation results presented in the previous section.

[6] We owe this point to Andy Cosh.

Table 5.1 here

First, we draw out common patterns based on the information summarised in Table 5.1. In general, lower consistency across countries emerges in relation to modes of innovation to do with new-to-market innovations, while process modernising and wider innovating patterns exhibit a greater consistency among the countries studied here. Nonetheless, all countries show some form of *new-to-market innovation modes*. The most general pattern suggest that new-to-market innovation is linked to own generation of technology, as indicated by high loadings associated with in-house R&D and IPRs. This suggests a more traditional and closed mode of innovation.

In Austria, Denmark and New Zealand diffused technology (externally acquired R&D) is commonly used in conjunction with own technology. The additional use of diffused technologies may be an indication of a more open innovation pattern among firms in these countries. In the case of Austria, Brazil, Denmark, Norway and South Korea, innovation may be relatively more design led as design activities are associated with modes of new-to-market innovations.

A further distinct pattern emerges based on new-to-market innovation. This mode of innovation links new-to-market innovation to strategies of appropriation: both formal and informal protection. Results for Canada, France, New Zealand and the United Kingdom suggest that firms use such strategies, perhaps consistent with greater reliance on the closed innovation model; i.e. with the exception of New Zealand firms are less likely to adopt external technologies, and, at the same time more likely to protect their own innovation efforts from imitation.

The second distinct innovation practice which emerges is interpreted as *process modernising*, involving acquisitions of machinery, equipment and software, with, the use of embedded technologies, alongside training of staff to apply the new assets`. Countries whose firms exhibit such innovation practices are Austria, Brazil, Canada, Denmark and the UK. Generally, technological activities in the form of in-house or acquired R&D play a lesser role, with the exception of South Korea where one factor/innovation mode links process innovation with internal and external R&D.

Organisational and marketing innovations are linked to this factor – process modernising – in the case of New Zealand and Norway. The latter is referred to in this report as *business process moderniser*, acknowledging a strategy which involves

changes to production processes in tandem with changes to the organisational structure and managerial techniques and competencies.

All countries for which information is available exhibit a mode or practice which we interpreted as *wider innovating*. Here, organisational and marketing related innovation strategies load up in one factor, as is the case based on data from Austria, Brazil, Denmark, and the UK. Alternatively, there are two separate factors linked to *organisational innovating* on the one hand and *marketing innovating* on the other hand. Countries are: France and South Korea.

A notable country specific result is for France, where one factor, titled *technology innovating and process modernising***,** emerges. This factor joins all forms of product and process innovation outputs, with technology – own, diffused and embedded – as well as training expenditures. Also, noticeable are the cross categories and innovation practices summarised here as *business process modernising* in New Zealand and Norway.

In the case of the results for Norway, there is a fourth factor which does not appear in Table 5.1 and which is referred to in the note below the table. This factor is titled *technology producing and using* and loads up on internal and external R&D. This factor has a positive association with new-to-firm and new-to-market product innovation, yet the loadings on the latter are not very pronounced (r=0.27 and r=0.23 respectively) and, therefore, it is not included in Table 5.1. The factor has a negative loading with process innovation outputs (r=-0.13).

A further example of a country specific finding over and above those highlighted in the country specific sections lies in the innovation practice summarised as *marketing based imitating* (new-to-firm product innovation) in the Brazilian case, where this is also linked to own and diffused technologies. In the case of South Korea, the factor "process modernising" exhibits high loadings on own and diffused technologies, next to machinery and training expenditures. Interesting findings from Austria suggests that design activities are connected with new-to-market innovating, and also with wider innovating (organisational and marketing innovating).

While there has been much progress in recent years in the area of innovation survey data, analyses of such data have focused on determinants and effects of innovation in products or processes. Relatively fewer attempts are made to further our understanding of (broader) innovation concepts, including innovation practices linked to design activities and advances in managerial techniques (for a survey of literatures

based on CIS see, Smith, 2005). From a methodological point of view, studies lean towards formal econometric modelling. While such studies spend much effort on addressing data constraints, including the use of cross-sectional data to show causality, we argue that the rich information and observable patterns in the existing data have been underutilised, and this is where this study attempts to add. Additionally, this paper adds by comparing firm level innovation practices systematically across nine countries. Comparative studies at this scale are difficult because of co-ordination costs and problems to do with the accessibility of data.

The key findings suggest that, while increased globalization may drive practices of innovation to become more homogeneous, distinct patterns in innovation practices specifically to do with new products (goods and services) remain important. These differences support the relevance of national boundaries when analysing innovation systems. While in-house R&D is relevant in almost all countries in relation to product innovation; some modes link internal R&D with IPRs suggesting closed innovation practices. Other firms apply practices of internal investment in innovation linked with external search for innovation; thus, follow an open approach to innovation. We identify modes of innovation practices which are design, or marketing lead. The mode 'business process modernising' reflects the growing importance of innovation practices tailored to the needs of service economies included in this study.

Albeit this study explores an extensive range of variables, the various theoretical concepts which influenced the data collection and the design of the Oslo Manual and CIS questionnaire may have influenced our findings. While this paper examines differences across countries, it does not explore sector specific practices. This is possible, and, indeed, further work for the UK looks into this issue. Important extensions of this work include an examination of the effects of different modes of innovation practices and firm performance.

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Table 3.1 Variables included in the explorative analysis of non-technological and technological activities

Variable description	Variable names
Product innovation	
Introduction of a new-to-firm product (that was not new to the market)	New-to-firm product innovation
Introduction of a new-to-market product	New-to-market product innovation
Process innovation	
Process innovation (methods of manufacturing; delivery or distribution methods)	Process innovation
Organisational and marketing innovation	
New knowledge management system	New knowledge management
Change to the organisation of work, incl. management structure	New organisational structure
Changes in the relationships to other firms, incl. partnerships	New relations with other organisations
Changes in design or packaging	New design or packaging
Changes sales or distribution methods	New distribution methods
Own technology	
Intramural R&D	In-house R&D
Enterprise applied for a patent	Patent
Diffused and embedded technology	
Extramural R&D	Extramural R&D
Expenditure on acquisition of machinery, equipment and software	Machinery
Expenditure on external knowledge acquisition	External knowledge
Design	
Registered industrial design	Design registration
Claim copyright	Copyright
Other inputs	
Expenditure on training	Training
Expenditure on market introduction of innovations	Marketing expenditures

Table 4.1 Factor analysis based on survey data from Austria

Factors / *Variables*	Factor 1 *New-to-market innovating*	Factor 2 *Wider innovating*	Factor 3 *Process modernising*	Factor 4 *Marketing based imitating*
New-to-firm product innovation				0.78
New-to-market product innovation	0.76			
Process innovation		0.34	0.56	-0.39
Advanced management techniques		0.70		
New organisational structure		0.69		
Improved appearance or design		0.71		
New marketing concepts/strategies		0.81		
In-house R&D	0.89			
Patent	0.88			
Extramural R&D	0.72			
Machinery			0.67	
External knowledge			0.68	
Design registration	0.79			
Copyright	0.52	0.31		0.36
Training			0.74	0.34
Marketing expenditures	0.32		0.45	0.59
Proportion of variance explained by each factor	0.24	0.16	0.14	0.09

N=540; data is CIS3; number of eigenvalues greater than 1=4. Tetrachoric correlations, unweighted data, rotation method variamax, values below 0.3 are suppressed. *Note*: definition of new to firm innovators – enterprises whose turnover from new to firm innovations is greater than turnover new to market innovations.
Source: CIS3 calculations by Martin Berger.

Table 4.2 Factor analysis based on survey data from Brazil

Factors / *Variables*	Factor 1 *New-to-market innovating*	Factor 2 *Marketing based imitating*	Factor 3 *Process modernising*	Factor 4 *Wider innovating*
New-to-firm product innovation		0.86		
New-to-market product innovation	0.87			
Process innovation			0.78	
New knowledge management	0.43		0.41	0.32
New organisational structure				0.63
New design or packaging				0.68
New distribution method				0.77
In-house R&D	0.70	0.53		
Patent	0.85			
Extramural R&D	0.53	0.46		
Machinery			0.88	
External knowledge	0.42	0.44	0.33	
Design registration	0.68			
Copyright	0.69			
Training	0.43	0.43	0.56	
Marketing expenditures	0.47	0.65		
Proportion of variance explained by each factor	0.26	0.14	0.14	0.11

N=4,476; data is; number of eigenvalues greater than 1=5. Tetrachoric correlations, unweighted data, rotation method variamax.
Source: PINTEC(2003) calculations by Bruno Araújo and João De Negri.

Table 4.3 Factor analysis based on survey data from Canada

Factors / *Variables*	Factor 1 *In-house / market driven innovating*	Factor 2 *Process modernising*	Factor 3 *IPR / external innovating*
New-to-firm product innovation	0.73		
New-to-market product innovation	0.73		0.30
Process innovation		0.76	
In-house R&D	0.71		
Patent			0.80
Extramural R&D			0.44
Machinery		0.79	
External knowledge		0.49	0.46
Design registration	0.35		0.47
Copyright			0.80
Training		0.75	
Marketing expenditures	0.70		

N=540; data is CIS3; number of eigenvalues greater than 1=4. Tetrachoric correlations, unweighted data, rotation method variamax, values below 0.3 are suppressed. *Note*: definition of new to firm innovators – enterprises whose turnover from new to firm innovations is greater than turnover new to market innovations. *Note:* the four factor solution (omitting process innovation) did not lead to separating new-to-market innovators from followers.
Source: Survey of Innovation (2005) calculations by Pierre Therrien.

Table 4.4 Factor analysis based on survey data from Denmark

Factors / *Variables*	Factor 1 *Technology producing and using*	Factor 2 *New-to-market / design innovating*	Factor 3 *Wider innovating*	Factor 4 *Process modernising*
New-to-firm product innovation	0.33	0.54		
New-to-market product innovation	0.39	0.62		
Process innovation				0.70
New knowledge management			0.60	
New organisational structure			0.70	
New relations other organisations			0.68	
New design or packaging		0.67	0.45	
New distribution method		0.42	0.57	
In-house R&D	0.93			
Patent	0.83			
Extramural R&D	0.86			
Machinery				0.72
External knowledge		0.31		0.40
Design registration		0.73		
Copyright		0.61		
Training			0.39	0.38
Marketing expenditures	0.40	0.62		
Proportion of variance explained by each factor	0.18	0.17	0.13	0.10

N=1,033; five factors with eigenvalues greater than one. Tetrachoric correlations, unweighted data, rotation method variamax, values below 0.3 are suppressed.
Source: CIS4 calculations by Carter Bloch.

Table 4.5 Factor analysis based on survey data from France

Factors / *Variables*	Factor 1 *Technology innovating and process modernising*	Factor 2 *Organisational innovating*	Factor 3 *IPR innovating*	Factor 4 *Marketing based innovating*
New-to-firm product innovation	0.64			
New-to-market product innovation	0.64			
Process innovation	0.74	0.31		
New knowledge management		0.74		
New organisational structure		0.72		
New relations other organisations		0.60		
New design or packaging				-0.80
New distribution method				-0.83
In-house R&D	0.77			
Patent	0.36		0.67	
Extramural R&D	0.61			
Machinery	0.76			
External knowledge	0.54			
Design registration			0.75	
Copyright			0.65	
Training	0.76			
Marketing expenditures	0.63			-0.37

N=19,304 (sample is not restricted to innovation active firms?); CIS4; four factors with eigenvalues greater than one. Pearson correlations, unweighted data, rotation method variamax, values below 0.3 are suppressed.
Source: CIS4 calculations by Fabrice Galia.

Table 4.6 Factor analysis based on survey data from New Zealand

Factors / *Variables*	Factor 1 *Business process modernising*	Factor 2 *Technology producing and using*	Factor 3 *IPR innovating*	Factor 4 *Marketing based imitating*
New-to-firm product innovation				0.84
New-to-market product innovation		0.48	0.51	
Process innovation	0.52			-0.40
New management technique	0.93			
New organisational structure	0.88			
New design	0.43	0.58		0.30
Improved marketing strategy	0.60	0.43		
In-house R&D		0.65		
Patent			0.87	
Extramural R&D		0.75		
Machinery	0.41	0.41		-0.35
External knowledge		0.53		
Design registration			0.79	
Copyright			0.79	
Training	0.61	0.39		
Marketing expenditures		0.65		0.45
Proportion of variance explained by each factor	0.20	0.18	0.16	0.09

N=1,887; BOS2005; five factors with eigenvalues greater than one. Tetrachoric correlations, unweighted data, rotation method variamax, values below 0.3 are suppressed.
Source: BOS2005 calculations by Richard Fabling and Julia Gretton.

Table 4.7 Factor analysis based on survey data from Norway

Factors / *Variables*	Factor 1 *Technology adopting*	Factor 2 *Business process modernising*	Factor 3 *IPR / design innovating*	Factor 4 *Technology producing and using*
New-to-firm product innovation			0.25	0.27
New-to-market product innovation	0.41		0.38	
Process innovation	0.33	0.50		
New management systems		0.78		
New organisational structure		0.79		
New relations other organisations		0.72		
New design or packaging		0.37	0.39	
New distribution method		0.66		
In-house R&D				0.84
Patent			0.73	0.41
Extramural R&D				0.84
Machinery	0.74			
External knowledge	0.67			
Design registration			0.88	
Copyright			0.77	
Training	0.83			
Marketing expenditures	0.79			
Proportion of variance explained by each factor	0.18	0.17	0.15	0.15

N=1,033; six factors with eigenvalues greater than one. Tetrachoric correlations, unweighted data, rotation method variamax, values below 0.25 are suppressed.
Source: CIS4 calculations by Svein Olav Nås.

Table 4.8 Factor analysis based on survey data from South Korea

Factors / *Variables*	Factor 1 *IPR/in-house innovating*	Factor 2 *Organisational innovating*	Factor 3 *Marketing innovating*	Factor 4 *Technology producing and using*
New-to-firm product innovation	0.74		0.31	0.35
New-to-market product innovation	0.73		0.32	
Process innovation	0.43	0.51		0.43
New management systems		0.78		0.31
New organisational structure	0.31	0.77	0.37	
New relations other organisations		0.83		
New design or packaging	0.37		0.80	
New distribution method		0.30	0.85	
In-house R&D	0.66	0.41	0.43	0.45
Patent	0.79	0.31		
Extramural R&D	0.42	0.34		0.66
Machinery	0.44	0.42	0.37	0.59
External knowledge	0.33	0.40		0.70
Design registration	0.77		0.34	
Training	0.33	0.48	0.40	0.61
Marketing expenditures			0.76	0.42
Proportion of variance explained by each factor	0.25	0.22	0.2	0.17

N=2,595; three factors with eigenvalues greater than one. Tetrachoric correlations, unweighted data, rotation method variamax, values below 0.3 are suppressed. Two factors with eigenvalues greater 1.
Source: Korean Innovation Survey 2005/6 calculations by Seok-Hyeon Kim.

Table 4.9 Factor analysis based on survey data from the UK

Factors / *Variables*	Factor 1 *IPR/in-house innovating*	Factor 2 *Process modernising*	Factor 3 *Wider innovating*	Factor 4 *Market driven innovating*
New-to-firm product innovation				0.72
New-to-market product innovation	0.36			0.50
Process innovation		0.40		-0.62
Advanced management techniques			0.80	
New organisational structure			0.83	
Marketing change			0.79	
In-house R&D	0.40	0.47		0.37
Patent	0.95			
Extramural R&D		0.63		
Machinery		0.81		
External knowledge		0.73		
Design registration	0.95			
Copyright	0.91			
Training		0.71		
Marketing expenditures		0.48		0.40
Proportion of variance explained by each factor	0.21	0.19	0.15	0.11

N=5,203; four factors with eigenvalues greater than one. Tetrachoric correlations, unweighted data, rotation method variamax.
Source: CIS4 own calculations.

Table 5.1 Summary of findings from the factor analyses

Modes of innovation	Austria	Brazil	Canada	Denmark	France	New Zealand	Norway	South Korea	UK
New-to-market innovating	Factor 1 based on own and *diffused technology*, and based on *design.*	Factor 1 based on own technology, and based on *design.*	Factor 3 based on *IPR/external innovating*. Factor 1 *in-house/market driven innovating* product innovations with own technology and marketing expenditures.	Factor 1 based on own technology and *diffused technology.* Factor 2 new-to-market and new-to-firm innovations with marketing and *design.*	Factor 3 based on *IPR innovating*. Factor 1 *Technology innovating and process modernising*. New-to-market, new-to-firm, process innovators, own and diffused technology, machinery and training.	Factor 2 based on own and *diffused technology and marketing*. Factor 3 based on *IPR innovating*.	Factor 1 based on *diffused technology, excl. own technology*. Factor 3 based on *IPR/design innovating*.	Factor 1 based on *IPR/in-house innovating* with own technology and *design.*	Factor 1 based on *IPR/in-house innovating*. Factor 4 based on new-to-firm innovation, marketing expenditures, *plus new-to-market, own technology.*
Marketing based imitating	Factor 4 based on new-to-firm innovation with marketing expenditures.	Factor 2 based on new-to-firm innovation with marketing expenditures, *own, diffused technology.*				Factor 4 based on new-to-firm innovators with marketing expenditures.	No directly associated factor.	No directly associated factor.	
Process modernising	Factor 3 based on process innovation, machinery and training.	Factor 3 based on process innovation, machinery and training.	Factor 2 based on process innovation, machinery and training.	Factor 4 based on process innovation, machinery and training.		Factor 1 *Business process modernising* based on process innovation, organisational innovation, marketing innovation, machinery and training.	Factor 2 *Business process modernising* based on process innovation linked with organisational innovations and not based on machinery and training.	Factor 4 process innovation, with *technology producing and using.*.	Factor 2 based on process innovation, machinery and training.
Wider innovating	Factor 2 joining organisational and marketing activities, *plus design.*	Factor 4 based on organisational and marketing innovation.	N/A	Factor 3 based on organisational and marketing activities.	Factor 2 organisational innovations. Factor 3 with marketing activities.			Factor 2 marketing innovating. Factor 3 organisational innovating.	Factor 3 based on organisational and marketing activities.

Note: country specific loadings of variables and country specific factors are italicised. In the case of Norway Factor 4 'technology producing and using' loads up in-house R&D, patents and extramural R&D. The interpretation of factor loadings are those of the authors of the paper.